CNC3 Installation Manual

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1 Disclaimer of Liability and Limitation of Warranty

Where the CNC box is supplied as a component and not as part of a complete control system it is assumed that the purchaser has sufficient electrical and electronic knowledge to handle the component competently.

It is further assumed that the purchaser has sufficient knowledge of safe working practices and the relevant Health & Safety regulations which apply to working with electrical and electronic systems to work safely with the component.

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2 Introduction to the CNC3 box

The CNC3 box has been designed to control CNC lathes, milling machines, PCB drills, routers, etc. In fact any machine which has 1, 2, 3 or 4 stepper motor driven axes. The stepper motors can also, optionally, be controlled in a closed-loop mode with the addition of standard quadrature encoders in either strip or rotary form.

The CNC3 box has a built in power supply which can output 36 volts DC @ 20 Amps.

A machine fitted with a CNC3 can be operated in a simplified stand-alone manual mode (for cleaning and maintenance, etc.) without requiring a host computer.

The CNC3 box can be fitted with 2, 3 or 4 STEPHP1 stepper motor drive cards. The CNC3 can also be supplied with 3rd party pseudo-stepper DC servo drive cards.

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2.1 Front panel controls

The front panel controls are (from left to right) the axis jog buttons for the X and Y axis (arranged in a cross around the green 'Enter'/BTN1 button), the Z axis jog buttons, 3 status LEDs, the electronic hand-wheel, the emergency stop button and the power switch.

When in manual mode the jog buttons can be used to rapidly position an axis and then the hand-wheel can be used to control the precise position. The hand-wheel automatically switches to operate the last axis that was moved with one of the jog-buttons. The electronic hand-wheel is rotated clockwise to move the axis in the positive direction and counter-clockwise to move the axis in the negative direction.

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2.2 Rear Panel Connections

The rear panel contains the plugs for: the mains supply, the computer, an AC/DC spindle motor (or any 10 Amp load), 12-volt relay drives, the stepper motorsand the feed-back/encoder/limit-switch plug.

AC Mains Inlet

The AC mains connector is a standard 'kettle' type plug (an IEC plug). The socket includes a 2 Amp fuse - do not use a higher rated fuse... it will reduce the level of protection!

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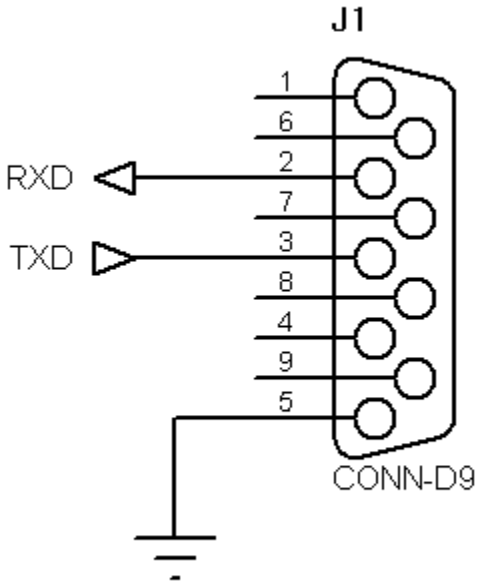
2.2.1 RS232 Serial Interface



Pin	Signal
2	Receive Data (RCD)
3	Transmit Data (TXD)
7	Ready-To-Send (RTS)
8	Clear-To-Send (CTS)
5	Ground

The serial port is configured as a standard PC AT 9-pin port. A standard PC-AT to PC-AT serial cable (a cross-over cable) can be used.
The default protocols are 115,200 baud, 8 data bits, no parity and 1 stop bit.
The board will use XON/XOFF flow controls by default.

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2.2.2 Spindle Motor control plug

Pin	Signal
1	Emergency stop
2	Emergency stop
3	Motor armature +
4	Motor armature -
5	Motor field +
6	Motor field -
7	Relay
8	Relay
9	Earth

The emergency stop circuit can be connected through any safety switches, cover switches, etc. Provided it is unbroken the spindle, coolant and programmes can be run. If the emergency stop circuit is broken then the spindle and coolant are forced off and any programme running will be stopped... the machine can still be moved in manual mode. **The plug supplied has a link shorting pins 1 and 2.**

The motor outputs (pins 3, 4, 5 and 6) are only available if the optional DCMOT1 card is fitted.

The relay connection (pins 7 and 8) can carry 10 Amps @ 240 VAC. The circuit is closed when spindle run is selected.

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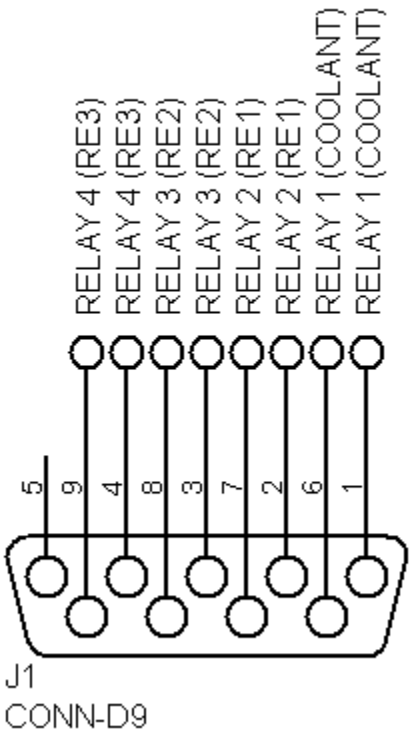
2.2.3 Relay drives plug



Pin	Signal
1	Relay 1 (Coolant)
6	Relay 1 (Coolant)
2	Relay 2 (RE1)
7	Relay 2 (RE1)
3	Relay 3 (RE2)
8	Relay 3 (RE2)
4	Relay 4 (RE3)
9	Relay 4 (RE3)
5	no connection

To drive a relay connect the coil across the 2 connections, i.e., connect a coolant relay across pins 1 and 6.

Each relay drive is capable of sinking 500 milli-amps of current but the combined current of all relays should not exceed 1 Amp.

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2.2.4 Stepper motor plug

Pin	Signal
1	X Motor A phase +
2	X Motor A phase -
3	X Motor B phase +
4	X Motor B phase -
5	Y Motor A phase +
6	Y Motor A phase -
7	Y Motor B phase +
8	Y Motor B phase -
9	Z Motor A phase +
10	Z Motor A phase -
11	Z Motor B phase +
12	Z Motor B phase -
13	U Motor A phase +
14	U Motor A phase -
15	U Motor B phase +
16	U Motor B phase -

N.B. As delivered the stepper motor outputs are configured for 2 Amps/phase and for half-stepping with power-save enabled. To change these settings please refer to the manual for the stepper motor drive card (STEPHP1).

*****WARNING** Never connect or disconnect a motor when the control box is powered up. Always turn off the control box and allow 2-3 minutes for the power-supply capacitors to discharge before connecting or disconnecting motors. Failing to observe this precaution could permanently damage your control box!***

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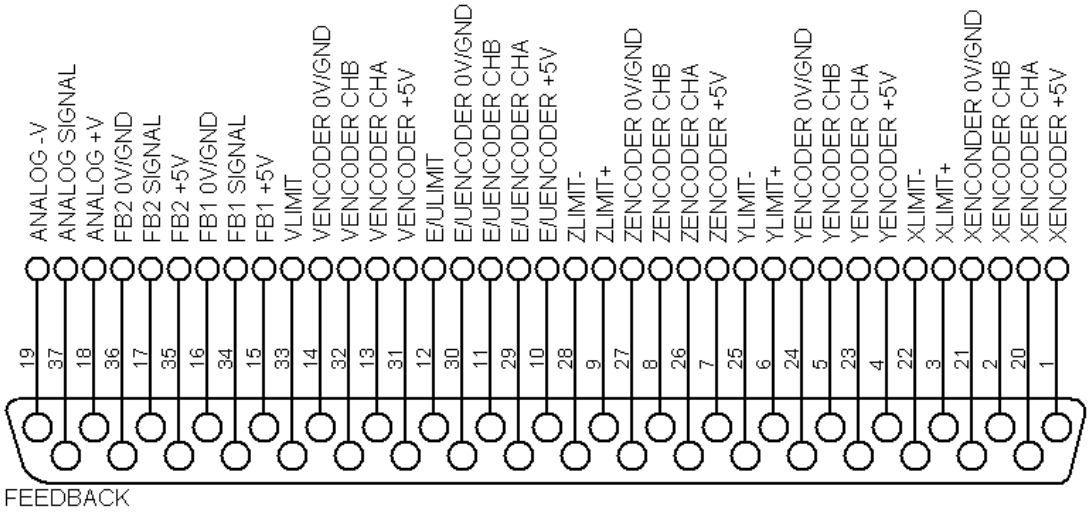
2.2.5 Feed-back/Encoder/Limit-switch plug



The power requirement of any encoder used should not exceed 100 milli-amps.

To connect a limit switch it should be connected between the limit switch input and the ground connection for the same section. For instance to connect an XLIMIT+ switch the switch would be connected across pins 3 and 21.

N.B. It is possible to use encoders which require a higher voltage than 5 volts by using the 12-volt supply from the relay plug and inserting a diode into the A and B lines. For details please contact technical support.

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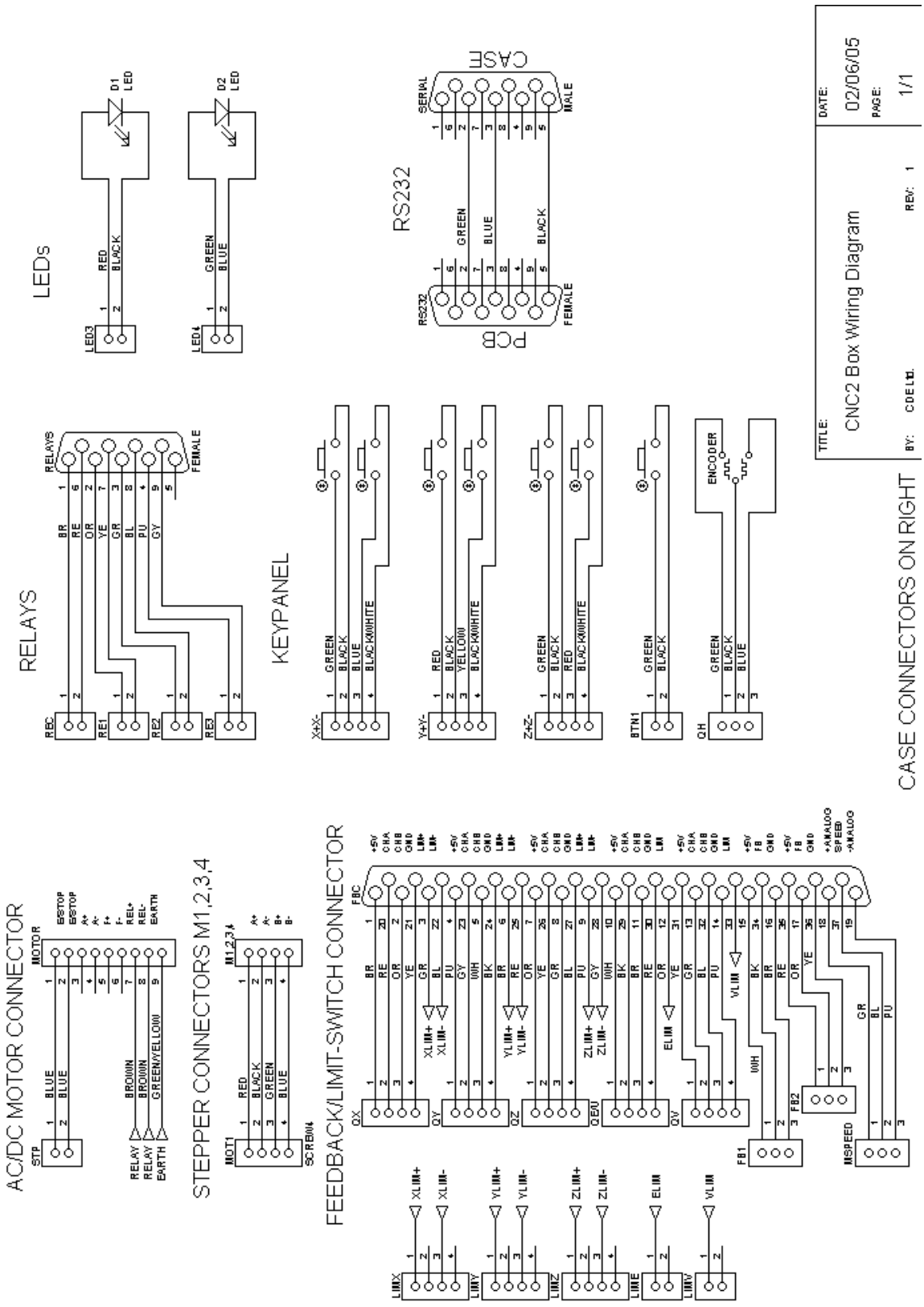
2.3 Internal Wiring



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2.4 Spare and replacement plugs

A replacement/spare plug for the stepper motors, feed-back/limit-switch connector, relay connector and DC motor/10-Amp-relay/Emergency-Stop connector can be obtained from RS Components (http://www.rswww.com) or Farnell Electronics (http://www.farnell.co.uk).

Stepper motor plug is... ""Connector, circular, CPC, cable plug, 16 way, 17 shell"

Feed-back/limit switch plug is... 37-pin male D-connector (plug)... various types are suitable.

Relay connector is... 9-pin male D-connector (plug)... various types are suitable.

RS Components code # 372-254, "Connector, circular, CPC, cable plug, 9 way, 13 shell".

Farnell Electronics code # 3195545, "RECEPTACLE, STD SLD CPC1 9 WAY".

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3 Manual Operation without a Computer

If no computer is attached the machine can be used in a rudimentary manner using the following jog-button and BN1 (button 1) combinations. The jog-switches operate as normal in manual mode when BN1 is not pressed.

Keys pressed	Action
BN1 & X+	Enter manual mode.
BN1 & X-	Exit manual mode.
BN1 & Y+	Turn spindle/spindle-relay on
BN1 & Y-	Turn spindle/spindle-relay off
BN1 & Z+	Toggle rapid and feed modes.
BN1 & Z-	Toggle coolant on/off.

If no button has been pressed for several minutes the machine will be switched out of manual mode.

When in manual mode the READY LED on the CNC box will flash continuously.

When in manual mode the hand-wheel can be used to precisely position an axis. The hand-wheel will control the last axis moved with the jog-buttons... so if X is to be controlled a tap either the X+ or X- button will set the hand-wheel to control the X axis. Turning the hand-wheel clockwise will move the axis in the positive direction and turning the hand-wheel counter-clockwise will move the axis in the negative direction.

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4 Appendices

4.1 G-Codes

G-Code	Parameters	Description
G00*	X, Y, Z, E	Rapid Move
G01*	X, Y, Z, E, F	Feed Move
G02*	X, Y, Z, E, I, J, K, F, R	Arc Clockwise Move
G03*	X, Y, Z, E, I, J, K, F, R	Arc Counter-Clockwise Move
G04	S	Dwell. S=Seconds to delay.
G05*	P	Spline function (Bezier curve) (only available when running with the EaziCNC software)
G17	-	Use XY plane for circular interpolation (Top)
G18	-	Use XZ plane for circular interpolation (Front)
G19	-	Use YZ plane for circular interpolation (Side)
G28	X, Y, Z, E	Home Axis
G40	-	Tool-nose compensation off (default mode)
G41	R	Tool-nose compensation Left-of-Line
G42	R	Tool-nose compensation Right-of-Line
G43	-	Tool-length compensation (positive)
G44	-	Tool-length compensation (negative - default mode)
G45	-	Cancel Tool-length compensation.
G54	X, Y, Z, E	Set home/reset position.
G70	-	Imperial coordinates (only available when running with the EaziCNC software)
G71	-	Metric coordinates (default mode)
G90	-	Absolute coordinates (default mode)
G91	-	Incremental coordinates (only available when running with the EaziCNC software)
G92	X, Y, Z, E	Set datum point.

N.B. The E axis can also be programmed as U.
*N.B. The codes marked with * are modal. Modal codes are active on any subsequent lines that do not have a code given.*

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4.1.1 Additional G-Codes for Lathe Operations

G-Code	Parameters	Description
G33	X, Z, P, I	Threading(/synchronized) cut. P is pitch, I is end pull-out in X.
G80	-	Cancel Canned Cycle
G81*	X, Z, P	Turning cycle
G82*	X, Z, P	Taper cycle
G83*	X, Z, I, K, R, P	Arc Clockwise Cycle
G84*	X, Z, I, K, R, P	Arc Counter-Clockwise Cycle
G85*	X, Z, P	Facing Cycle
G86*	X, Z, P, I, K, R	Threading(/synchronized) cut cycle. X is pass offset (pass depth). P is pitch, I is end pull-out, K is pass offset in Z and R is number of passes.
G94	-	Feed rates in mm./in. per minute
G95	-	Feed rates in mm./in. per spindle revolution
G96	-	Constant surface speed. Feed rate specified in mm. at 20.0 mm. diameter. Feed rate specified in inches at 1.0 inch diameter.

N.B. The E axis can also be programmed as U.
*N.B. The codes marked with * are modal. Modal codes are active on any subsequent lines that do not have a code given.*

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4.1.2 Additional G-Codes for Milling Operations

G-Code	Parameters	Description
G50	-	Mirror Off. Cancel any mirrored axis.
G51	X, Y, Z, E	Mirror. Mirror selected axis (around coordinate given).
G55	-	Offset Off. Cancel/Clear temporary origin
G56	X, Y, Z, E	Offset. Set temporary origin.
G80	-	Cancel/Complete Canned Cycle.
G81*	Z	Drill, Spot-Drill
G82*	Z, K	Peck Drill
G83*	Z, P	Tapping
G84*	Z	Bore
G85*	Z, P	Pocket cycle.

N.B. The E axis can also be programmed as U.
*N.B. The codes marked with * are modal. Modal codes are active on any subsequent lines that do not have a code given.*

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4.2 M-Codes

M-Code	Parameters	Description
M00	-	Programme Stop
M01	-	Optional Stop
M02	-	Programme End (same as M30)
M03	S	Spindle Start Clockwise
M04	S	Spindle Start Counter-clockwise
M05	-	Spindle Stop
M06	R, T, X, Y, Z	Tool Change
M08	-	Coolant On
M09	-	Coolant Off
M13	S	Spindle Start Clockwise + Coolant On
M14	S	Spindle Start Counter-clockwise + Coolant On
M15	-	Spindle Stop + Coolant Off
M30	-	Programme End (same as M02)
M47	R	Return to Programme Start. R is the repeat count (if given)
M90	P	Relay P On
M91	P	Relay P Off
M92	P	Wait for input P to be Low
M93	P	Wait for input P to be High
M94	-	Index tool-post. Indexes the tool-post (if fitted) forward.
M98	-	Motor Drives On
M99	-	Motor Drives Off

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4.3 Command Set

Command	Parameters	Description
Ctrl-B (#2)	-	Query. Used by the EaziCNC software.
Ctrl-E (#5)	-	Echo On. Echoes characters back to the terminal and enables user friendly responses (data sent to the terminal will have a tag, i.e, "P0:0" instead of just "0").
Ctrl-N (#14)	-	Echo Off. Stops characters from being echoed back to the terminal and disables user friendly responses.
<ESC>	-	Escape. Stops any current moves or commands. Clears the command buffers. This command does not need to be completed with a carriage return (CR).
@	-	At. Returns the current position and status data in compressed hex format. This command does not need to be completed with a carriage return (CR).
D	n<CR>	Message-mode. Controls whether messages are sent to the console. n=0 - do not show messages n=1 - show messages (including updates when moving) n=2 - debugging mode
EC	-	Error Clear. Clears any error state on the machine. *N.B. this clears user-stops, power-up errors, etc. it will not and cannot clear errors such as 'safety activated'.*
ES	-	Error Status. Displays the error code of the machine. Error codes... 0 - No error 1 - Stopped by user 2 - Stopped - safety activated 3 - Power interrupted 4 - X-limit triggered 5 - Y-limit triggered 6 - Z-limit triggered 7 - E-limit triggered
I	n<CR>	Info. <n> is the item of information 0 - board ID 1 - firmware version 2 - firmware date 3 - processor type <blank> - firmware banner

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MA	<CR>	Manual Mode. To exit manual mode the <ESC> command must be sent.
P	n[Rv]<CR>	Parameter. Query (or set) a parameter. See control parameters for a description. P99 will display parameters 0 to 19. P199 will display parameters 20 to 39.
SX	f<CR>	Set X coordinate to <f>
SY	f<CR>	Set Y coordinate to <f>
SZ	f<CR>	Set Z coordinate to <f>
SE	f<CR>	Set E coordinate to <f>
SH	<CR>	Show Home. Displays the currently set home/starting position (set by a G54 command).
ST	<CR>	Status. Show current status.
T	X, Y, Z	Set/display tool offset. If no X, Y or Z is given then the existing offset will be displayed. T99 will list all tool offsets.

Any valid ISO line will also be interpreted and executed on the machine tool. For a list of valid ISO (G&M-codes) see G-Codes and M-Codes.

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4.4 Control Parameters

Parameter	Type	Description
0	Binary	Configuration 1 - see detailed explanation below.
1	Binary	Configuration 2 - see detailed explanation below.
2	Integer	Minimum Spindle Speed. Default=200 RPM
3	Integer	Maximum Spindle Speed. Default=2000 RPM
4	Integer	Maximum Cutting Feed Rate. Default=400 mm./min.
5	Integer	Rapid Feed Rate. Default=800 mm./min.
6	Integer	Pulses/Revolution on Threading/Synchronizing Encoder. Default=360 [Setting this to 0 will cause the slots to be counted]
7	Integer	Default Circular Interpolation Mode. 0=XY, 1=XZ, 2=YZ.
8	Integer	X-scale (X-step size in millimetres = (P9/P8)/P19)
9	Integer	X-divisor (X-step size in millimetres = (P9/P8)/P19)
10	Integer	Y-scale (Y-step size in millimetres = (P11/P10)/P19)
11	Integer	Y-divisor (Y-step size in millimetres = (P11/P10)/P19)
12	Integer	Z-scale (Z-step size in millimetres = (P13/P12)/P19)
13	Integer	Z-divisor (Z-step size in millimetres = (P13/P12)/P19)
14	Integer	E/U-scale (E-step size in millimetres = (P15/P14)/P19) Also used for V & W
15	Integer	E/U-divisor (E-step size in millimetres = (P15/P14)/P19) Also used for V & W
16	Integer	Scalar for Feed rates. Steps/sec=625,000*P17/(Feed*P16).
17	Integer	Divisor for Feed rates. Steps/sec=625,000*P17/(Feed*P16).
18	Integer	Decimal digits in coordinates. Default=2 digits

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19	Integer	Divisor for coordinates. Default=100
20	Binary	Control capabilities (see detailed description below). Do not alter!
21	Integer	Delays for carousel tool post. Forward delay = (low byte + 1)*0.25 secs Reverse delay = (high byte + 1)*0.25 secs [For stepper driven carousels 32768 (high bit) + steps/100. Reverse is half of forward steps]
22	Integer	Time-out for manual mode and automatic motor turn-off
23	Integer	Ramp stages (Maximum 16)
24	Integer	Ramp 0
25	Integer	Ramp 1
26	Integer	Ramp 2
27	Integer	Ramp 3
28	Integer	Ramp 4
29	Integer	Ramp 5
30	Integer	Ramp 6
31	Integer	Ramp 7
32	Integer	Ramp 8
33	Integer	Ramp 9
34	Integer	Ramp 10
35	Integer	Ramp 11
36	Integer	Ramp 12
37	Integer	Ramp 13
38	Integer	Ramp 14
39	Integer	Ramp 15
40	Integer	Back-lash compensation for X axis (steps)
41	Integer	Back-lash compensation for Y axis (steps)
42	Integer	Back-lash compensation for Z axis (steps)
43	Integer	Back-lash compensation for E/U axis (steps)
44	Integer	Back-lash compensation for V axis (steps)
45	Integer	Back-lash compensation for W axis (steps)
46	Integer	Low byte - deadband for X, high byte - deadband for Y

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47	Integer	Low byte - deadband for Z, high byte - deadband for E/U
48	Integer	Low byte - deadband for V, high byte - deadband for W
49	Integer	Max. encoder failure count allowed
50	Integer	X-encoder scale
51	Integer	X-encoder divisor
52	Integer	Y-encoder scale
53	Integer	Y-encoder divisor
54	Integer	Z-encoder scale
55	Integer	Z-encoder divisor
56	Integer	U/V/W-encoder scale
57	Integer	U/V/W-encoder divisor
58	Integer	Reserved
59	Integer	Reserved

Configuration 1 (parameter 0)

bit 1	X axis direction
bit 2	Y axis direction
bit 3	Z axis direction
bit 4	E axis direction
bit 5	X axis home direction
bit 6	Y axis home direction
bit 7	Z axis home direction
bit 8	E axis home direction
bit 9	Turn off motor drives when inactive
bit 10	Override Safety switch (spindle and coolant will not run)
bit 11	Override Safety switch (spindle and coolant will run). MPC4 & MPC5 only.
bit 12	LED4 shows busy state (MPC4/MPC5 only)
bit 13	RELAY4 is reserved for motor reverse (MPC4/MPC5 only)
bit 14	tool carousel on motor E. [delay is (param21+1)*0.25 secs]
bit 15	reserved
bit 16	reserved

Configuration 2 (parameter 1)

bit 1	X feedback active
bit 2	Y feedback active
bit 3	Z feedback active
bit 4	E feedback active
bit 5	X limit active
bit 6	Y limit active
bit 7	Z limit active
bit 8	E limit active

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bits 9&10	1st axis to home (0=X, 1=Y, 2=Z, 3=E)
bits 11&12	2nd axis to home
bits 13&14	3rd axis to home
bits 15&16	4th axis to home

Control Capabilities (parameter 20)

bit 1	0 - Control does not support G2/G3 directly 1 - Control supports G2/G3 directly
bit 2	0 - Control does not support G5 directly 1 - Control supports G5 directly
bit 3	0 - G17 default mode for circular interpolation 1 - G18 default mode for circular interpolation
bit 4	reserved
bit 5	reserved
bit 6	reserved
bit 7	reserved
bit 8	reserved
bit 9	reserved
bit 10	reserved
bit 11	reserved
bit 12	reserved
bit 13	reserved
bit 14	reserved
bit 15	reserved
bit 16	reserved

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